allowing the maximum tolerance for pins that may not be in precisely the correct position as they approach and encounter retaining device **99**. It minimizes the risk of a pin jamming in an intermediate position and holds the raised pins with a tight tolerance while they pass through the reading aperture to assure that rounded ends **84** of pins **81** are a correct height above surface **33** of wheel **27** to serve as detectable Braille dots. Retaining device **99** is preferably narrower and/or more centered (relative to pin length at full retraction) at leading edge **179** of the device to better separate pins **81** into retracted or extended states, and is preferably thicker, and thereby closer to wheel surface **104** in the reading area for precise position control of raised pins **81**. Depending upon the dimensions of pin heads **85** with respect to the pin shaft **83** diameter, it may be sufficient to have passive position retention device **99** contact only one side of the pin (head and shaft) thereby eliminating the redundant elements **187** of the device utilized to define slots **185**.

[**0100**] For all passive positioning devices **165**, **101** and **99** shown hereinabove, pin head **85** configuration is important. The various ramps and elements that provide pin raising, lowering and/or retention must be able to contact underface **183** of pins **81** if they are to be lowered (retracted) or retained, and must be able to slide along the pin edge smoothly if they are to be raised (extended).

[**0101**] In particular, where a pin **81** is so extended as to be in contact with surface **104** of wheel **27**, a ramp structure **169** utilized for retracting the pin must be able to be inserted between pin head **85** and surface **104** at its leading edge **175**. In addition to the edges of pin heads **85** being well rounded or otherwise sloped, a thin ridge of material **191** is preferably incorporated with pins **81** (a collar as shown in **FIG. 18**) and/or at openings **93** at surface **104** of wheel **27** (a surrounding lip as shown in **FIG. 19**) to prevent pin movement to a fully flush position with surface **104** and allow a gap for more ready acceptance of leading edge **175** of ramp structure **169**.

[**0102**] In the event of geometric constraints, for example the diameter of each of the actuators **49** being greater than the spacing between adjacent rows **121** in a Braille cell, methods can be used to concentrate the effects of the multiple actuators **49** down into the space required (i.e., to fit the actuators to the available space). Some such methods include use of shaft linkages **195** (mechanical or flexible linkages, for example) as illustrated in **FIG. 20**, or utilization of different pin and/or actuator shaft **51** lengths (see **FIG. 21**, for example, wherein actuators **49** are staggered and employ different shaft **51** lengths).

[**0103**] **FIG. 22** shows a combination actuator/passive position retention device **200** that includes a flexible or hinged extension **202** positionable by actuator **49** to act as a ramp, guiding pins **81** that contact the ramp from a default position to a non-default position. When extension **202** is raised by actuator shaft **51**, pin heads **85** pass underneath it and remain in the default position. The connection between actuator shaft **51** and extension **202** is offset relative to a line defined by a row **121** of pins **81** so that the moving pins do not impact actuator shaft **51**. This permits use of a relatively long ramping and, thus, a relatively shallow slope to move pins **81**. Changes in position of extension **202** while pins **81** are in transit therealong will cause those pins on the ramp defined by extension **202** to be immediately shifted by some amount but will not effect the final positions of the pins in the reading aperture.

[**0104**] The construction of rotatable outer rim **105** of **FIG. 6** can be single piece, with pin shaft openings **93** drilled or molded, or multiple piece, one or two ring layers per row **121** of Braille pins. If assembly **92** is placed in an assembly workstation with drive shaft **109** pointed down, pins **81** may be inserted in openings **93** of outer rim **105** and then rotating assembly **92** lowered down and fitted into place in housing **37**. Non-rotating assembly **95** will prevent pins **81** from falling out of outer rim **105** once it is in place.

[**0105**] The techniques described for a wheel-based display could also be applied to a more conventional structure of a line display. As shown in **FIG. 23**, pins **81** can be placed in a linear, nonmoving matrix **208** at a housing (not shown), and assembly **210** moved underneath pin matrix **208** to set pins **81** and thus the Braille dots as heretofore disclosed. Moving assembly **210** includes a passive pin default positioning device **212** (a two ramp structure generally of the type shown in **FIGS. 14 and 15** for lowering pins **81**), followed by actuators **49** (one for each row of pins, three or four total for the entire line) and passive pin position retention device **99**. Assembly **210** as shown moves from left to right, with establishment of pin default position being assured at forward ramp **214** of device **212**, writing and fixing the Braille text as it moves. When the user is finished reading the line of Braille text streamed across reading area **33** and signals for a refresh, moving assembly **210** travels back (from right to left in the FIGURE), with actuator shafts **51** retracted. The reversed ramp **216** of passive default positioning device **212** lowers any pins **81** that were raised to allow passage of passive default positioning device **212** during return.

[**0106**] Instead of device **212**, pin reset can be performed as a separate function, for example by a roller or magnet that sweeps across the display area. Additionally, it may be desirable to shield the part of the line of Braille text being written from finger contact, by a protective cover over the section of the display that is being written (at actuator **49**) and that follows the position of the moving actuator or actuators. The cover should not prevent tactile access to pins **81** that have already been set and that are being held in place by retention device **99**. With such a cover in place, the actuators that set the pins need not work against finger pressure, permitting faster writing action, with lower powered actuators. Actuators **49** that set pins **81** need not be mounted directly on assembly **210**. Mechanical linkages to assembly **210** responsive to actuators **49** located at a fixed position could be conceived to drive a mechanical pin setting apparatus at assembly **210**.

[**0107**] Passive pin retention device **99** is configured to be as long as the entire line of Braille cells in the display. Thus the entire Braille display assembly in this case will be more than twice as long as the line of Braille displayed. If, however, the passive pin retention device is made of strips of flexible material, supported along the sides away from the pins and of sufficient flexibility to support large-radius curves along its length but sufficiently stiff to prevent lateral flexing (steel tape for example), then the strips may be guided along tracks, grooves and/or wheels to wrap around under the moving assembly and thus extend to at its end in